FLUID-STRUCTURE INTERACTION ON A FIXED FAN BLADE

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High global electricity demand is pushing engineers towards providing hydropower electromagnetic generators with more resistant rotary equipment against well-known problems such as fatigue and vibrational cracking. The aim is to make power plants immune against high time and cost consuming refurbishments. In these systems, one of the rotating parts that is most susceptible to such failures is the ventilation fan. It is often an axial fan with blades distributed at one or two ends of the machine. The blades are attached to, and rotating with, the same shaft as the rotor, pushing the air through the rotor and stator towards the cooler. The blades are often manufactured by simple bent plates that are welded to the rotor, to keep the cost at minimum. They operate in an air flow that is highly restricted to the space that is available when the electromagnetic parts of the machine have been designed, causing temporally and spatially varying and non-ideal flow angles. For such conditions it is vital to study fluid-structure interaction on the blades to be able to avoid fan blade failures. Broken fan blades may cause severe damages to other parts of the machine, at enormous costs of repair and down-time. The present work provides a numerical study of the aeroelastic behaviour of a fixed blade resembling a blade of a double-sided axial fan of a hydropower generator. The focus is on flow-induced fluttering and resonance due to vortex shedding. The fluid-structure interaction is captured using the solids4Foam toolbox, which is an open source module for OpenFOAM, including specific solvers for solid and fluid mechanics and fluid-structure interaction. The turbulence is modelled using the scale-adaptive SAS model, which is able to capture vortex shedding with a combination of moderate computational costs and acceptable accuracy.

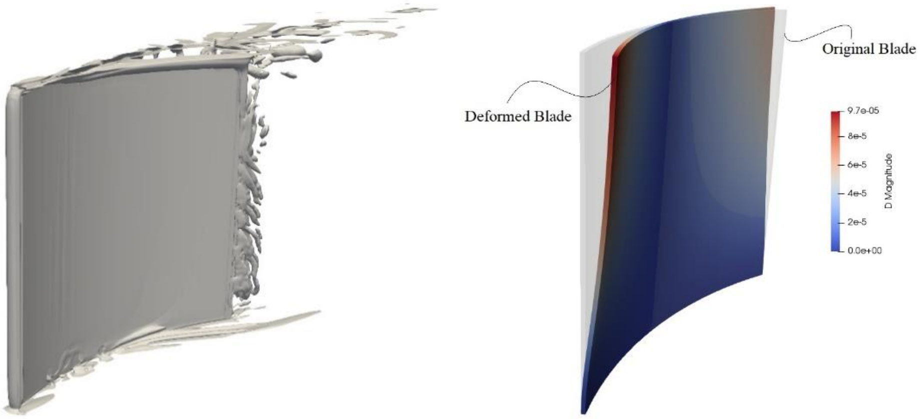

Figure 1: Left) Vortical structures, Right) Instantaneous magnified deformation of the blade

Figure 1 shows the blade geometry, which has an extruded circular arc cross-section that is connected to a base plate at the lower side and has a thin clearance to a cover at the upper side. Iso-surfaces of the Q-criterion in the left picture, show the vortical structures at the tip and trailing edge. In the right picture, an instantaneous exaggerated deformed shape of the blade is shown under the working condition.

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